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REPORT ON THE NDC CAPACITY BUILDING AND REGIONAL SEISMIC TRAVEL TIME WORKSHOP AND TRAINING

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Disclaimer

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REPORT ON THE NDC CAPACITY BUILDING AND REGIONAL SEISMIC TRAVEL TIME WORKSHOP AND TRAINING

14-18 October 2013
San Juan, Argentina
Instituto Nacional de Prevención Sísmica
INPRES

Stephen Myers, Lawrence Livermore National Laboratory
Michael Begnaud, Los Alamos National Laboratory

Drs. Stephen Myers and Michael Begnaud represented the U.S. at the National Data Center Capacity Building and Regional Seismic Travel Time Workshop and Training, which was held at the Instituto Nacional de Prevención Sísmica (INPRES) in San Juan, Argentina from 14 to 18 October 2013. This report focuses on the Regional Seismic Travel Time (RSTT) half of the workshop.

Workshop participants included representatives from 17 Latin American countries, the U.S., U.K., and the CTBTO. Appendix I contains the list of participants.

Table 1: Countries and Organizations Represented

Argentina	Dominican Republic	Panama
Bahamas	Ecuador	Paraguay
Bolivia	Guatemala	Inter. Seisolo. Center: U.K.
Brazil	Haiti	LLNL, LANL: U.S.
Chile	Jamaica	Venezuela
Colombia	Mexico	CTBTO
Costa Rica	Nicaragua	

The first half of the week was dedicated to national data center (NDC) capacity building. Presentations by representatives of the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) provided overviews of

- CTBT goals and objectives,
- The role of States-Parties to the CTBT,
- Operation of the International Data Center (IDC),
- The role of NDCs,
- Products available to NDCs from the IDC,
- Capacity building efforts in Latin America, and

The NDC workshop also included reports and statements from workshop participants on their seismic networks and CTBT-related activities.

The workshop agenda is provided in Appendix II.

Appendix III has a selection of photos from the workshop.

The RSTT half of the workshop had the following goals

- Introduce RSTT method and describe why it can help CTBTO and NDCs,
- Demonstrate improved seismic-event location using RSTT
- Provide hands-on training for using RSTT with a location program
- Describe the RSTT outreach effort
    - Integrate the results of participants' geophysical studies into the RSTT model.
    - Solicit contributions of "ground-truth" event locations and associated arrival-time measurements to the ISC repository.
    - Foster a collaborative effort to update the RSTT model using seismic tomography.
    - Provide hands-on training on how to update the RSTT model.

Overview of Selected RSTT Presentations

Dr. Stephen Myers provided an overview of the RSTT effort. The presentation included a description of the model parameterization and the method of travel time calculation. Millisecond RSTT computation time on readily available computers was emphasized, because it is this feature that makes RSTT accessible/usable by most of the participants. Later in the workshop, Dr. Myers demonstrated the RSTT Node Get and Set (RSTT_NOGS) utilities that allow users to output RSTT model parameters to ASCII files, edit the ASCII files, and upload the edits to a new RSTT model. RSTT_NOGS enables users to experiment with the effect of model changes on regional travel times.

Dr. Marcelo Assumpcao from the University of Sao Paulo, Brazil showed locations of several earthquakes along the Andes Mountains – which is where most seismicity occurs in South America – using conventional travel time methods and RSTT. Locations based on local seismic deployments are available for each of the events used in his study, providing epicenter accuracy of approximately 5 kilometers. Locations determined using a regional network and conventional travel time methods were shown to be biased by tens of kilometers. For the specific example events from Dr. Assumpcao a location bias of 50 kilometers was observed. Locations determined using a regional network and RSTT were shown to be within 10 km of the local-network location and bias was significantly mitigated. Dr. Assumcao's independent assessment of RSTT performance carried considerable weight with the participants.

Dr. Jordi Julia and from the Federal University of Northern Rio Grande (Brazil) presented on research efforts to develop a new model of crustal thickness for South America. This work has been done jointly with Dr. Assumpcao at University of Sao Paulo. The new model differs significantly from the global model of crustal thickness on which RSTT is currently based. Because regional travel times can be quite sensitive to crustal thickness and RSTT tomography does not attempt to change crustal thickness,

incorporation of Dr. Assumpcao's and Dr. Julia's crustal thickness model into the RSTT model was deemed a top priority. Dr. Myers used RSTT_NOGS to make this update.

Dr. Istvan Bondar from the International Seismological Center (ISC) presented on efforts to collect ground truth events globally. Because exact ground truth events (perfectly known location and origin time) with clear regional (much less global) signals are so rare, the seismic community extends the term "ground truth" to include uncommonly well-constrained locations that utilize a local network within 200 km of the event. The ISC ground truth database is openly available on the web (http://www.isc.ac.uk/gtevents/). Prior to the RSTT outreach effort in South America, the ISC ground truth database included only a few events that were gleaned from global bulletins. These ground truth events were clustered in 3 locales along the Andes Mountains. RSTT outreach has prompted contribution of dozens of new ground truth events. Most importantly, the new events are distributed throughout South America, providing new constraints on the RSTT model. In addition to the ISC ground truth database, Dr. Bondar described his ISC location code, which has been modified to work with RSTT. The ISC location code can be downloaded from http://www.isc.ac.uk/iscbulletin/iscloc/index.php.

Dr. Michael Begnaud gave an overview of tomographic imaging methods that have been used to optimize RSTT seismic wave speed for travel time prediction accuracy. Data sets and tomographic results for Eurasia, North America, and South America were presented. The presentation demonstrated that RSTT efforts in Latin America have contributed significantly to data coverage across South America, but holes in data coverage remain. Later in the workshop, Dr. Begnaud presented a new RSTT model. The new model is based on a tomographic inversion that includes data contributed through RSTT outreach activities. The results demonstrated that RSTT outreach activities have significantly improved data quality and coverage across South America and the Caribbean. Many of the South American researchers identified additional regional data for the tomography effort and suggested that they will continue to gather and provide this data for future efforts.

Students Funded Under RSTT Outreach

The U.S. funded two Argentine students through the CTBTO to work on data collection and model development at INPRES. The students are Brahim Aguil and Agostina Venerdini. Mr. Aguil and Ms. Venerdini have worked on RSTT-related projects since the Fall (southern hemisphere) of 2013, and they presented on their accomplishments at the workshop. Their accomplishments include: recovering seismic arrival times associated with ground-truth events from the INPRES database; relocating events using a local network to add to the ground truth database; and developing new models of the crust for locales near San Juan, Argentina. They have made good progress in their efforts and their work should continue. The students are currently attending the National University of San Juan and both plan to graduate in Summer or Fall (southern hemisphere) of 2014. After graduating Mr. Aguil and Ms. Venerdini U.S. will continue their work at INPRES under the funding provided by the U.S./CTBTO.

Hands On Exercises

The CTBTO rented approximately 10 PC laptops to facilitate hands-on activities. The PCs included a Linux virtual machine with copies of the NDC-In-A-Box software and the ISC locator. Prior to the workshop Drs. Bondar and Myers distributed a set of ground truth events and requested that participants contribute arrival times and/or waveforms associated with those events to the workshop. Data formatting issues precluded full use of waveform data, but the GeoTool software, which is part of NDC-In-A-Box, was used to view some contributed waveforms. Following an instructional presentation by Dr. Bondar on the use of the ISC locator, workshop participants were able to relocate events using RSTT. Likewise, workshop participants were able use the RSTT_NOGS codes to output RSTT model parameters, modify the parameters, and upload to a new model. We find that detailed instruction and hands-on activities are essential to achieving the goal of widespread use/adoption of the RSTT method at Latin American NDCs and research institutions.

Future Activities

The CTBTO coordinator for RSTT Latin America outreach, Dr. Federico Guendel announced that he plans to hold an RSTT workshop in Central America in the Spring of 2014. The workshop will follow the format established in San Juan. We expect an announcement from the CTBTO about the Central America workshop in December of 2013 or January of 2014.

The Regional Assembly of the Latin American and Caribbean Seismological Commission will hold a profession conference from July 23-25, 2014 in Bogota, Columbia. Dr. Assumpcao and other workshop participants suggested that RSTT collaborators meet on the margins of that conference to discuss their uses of RSTT and provide feedback to the U.S. National Laboratories.

Appendix I: List of participants

Name			Country
Mr	Juan Pablo	Aguiar	Argentina
Mr	Mario Antonio	Bufaliza	Argentina
Mr	Marcelo Pablo	Moreno Zuanni	Argentina
Mr	Rodolfo Rafael	Recio	Argentina
Mr	Horacio Daniel	Sanchez	Argentina
Mr	Richardo Gabriel	Sifon	Argentina
Mr	Brahim	Aguil	Argentina
Mr	Mario Rubén	Fernández	Argentina
Ms	Luciana	López	Argentina
Mr	Gerardo Raúl	Sánchez Girino	Argentina
Ms	Veneridini	Agostina	Argentina
Mr	Javier	Santo	Argentina
Mr	Paul Alexander	Coleman	Jamaica
Mr	Francisco Antonio	Peralta Belmonte	Paraguay
Mr	Dmitry	Storchak	UK
Mr	Istvan	Bondar	UK
Mr	Laverne Shezelle	Mather	Bahamas
Ms	Teddy	Grifiths	Bolivia
Mr	Marcelo Sousa de	Assumpcao	Brazil
Mr	Jordi	Julia Casas	Brazil
Mr	Sebastian	Riquelme	Chile
Ms	Patricia	Pedraza Garcia	Colombia
Mr	Hugo Esteban	Poveda Nunez	Colombia
Mr	Ronnie	Quintero	Costa Rica
Mr	Jose Ramon	Delgado Nin	Dominican Republic
Mr	Felix	Martinez	Dominican Republic
Mr	Mario	Ruiz	Ecuador
Mr	Nelson Javier	Santo	Ecuador
Mr	Luis Alberto	Bautista	Guatemala
Mr	Robin Onelio	Yani Quiyuch	Guatemala
Mr	Frantz	SAINT-PREUX	Haiti
Ms	Karleen Marie	Black	Jamaica
Mr	Laurel Anthony	Choy	Jamaica
Mr	Victor Hugo	Espindola Castro	Mexico
Mr	Creyving Jose	Arguello Miranda	Nicaragua
Ms	Martha Vanessa	Herrera Jimenez	Nicaragua
Mr	Nestor Antonio	Luque Vergara	Panama
Mr	Juan Carlos	Velazquez Monzon	Paraguay
Mr	Moises Alejandro	Gadea Villalba	Paraguay

Mr	Edmundo	Norabuena	Peru
Mr	Herbert	Rendon	Venezuela
Mr.	Michael	Begnaud	U.S.A
Mr.	Stephen	Myers	U.S.A
Mr.	Federico	Guendel	CTBTO
Mr.	Jeffrey	Given	CTBTO
Ms.	Misrak	Fesseha	CTBTO

Appendix II: Workshop Agenda

DRAFT PROGRAMME AGENDA

NDC CAPACITY BUILDING AND REGIONAL SEISMIC TRAVEL TIME WORKSHOP AND TRAINING

14-18 October 2013

San Juan, Argentina
Instituto Nacional de Prevención Sísmica
INPRES

Monday, 14 October 2013

09:00 – 09:45	Registration of Participants
09:45 – 10:00	Welcoming remarks: • *Representative from host Country: Welcoming speech by Mr. Alejandro GIULIANO, Director General of INPRES* • *Representative from, Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) : Workshop overview and expectations by Mr. Jeffrey GIVEN, Chief of Software Applications Section*
10:00 – 10:30	Status of Capacity Building Project in Latin America and the Caribbean's: Current State of Data & Product Usage in LAC Region, Latest developments and Future Plans. • *Ms. Misrak FISSEHA (IDC)*
10:30 – 11:00	Coffee Break and Group Photo
11:00- 12:00	Integrating IMS data with National/Regional data, Capacity Building Systems Installations, NDC Training and NDC Follow up Visits in LAC region: Experience & Lessons Learned • *Mr Ronnie QUINTERO (Costa Rica NDC)*
12:00- 12:30	Follow-up Exercises on NDC Trainings and National Preparedness Exercises (NPE): Experience & Lessons Learned • *Mr. Jeffrey GIVEN (IDC)*

12:30 – 13:30 *Lunch break*

13:30 - 15:00 National Experiences in Establishing and Operating an NDC: Presentations by Capacity Building Beneficiary Countries *(15Min.each)*

- *Mr. Jeffrey GIVEN, Mr. Federico GUENDEL and Ms. Misrak FISSEHA (Moderators)*
    - *Argentina*
    - *Bahamas*
    - *Bolivia*
    - *Brazil*
    - *Chile*
    - *Colombia*
    - *Costa Rica*
    - *Dominican Republic*
    - *Ecuador*
    - *Guatemala*
    - *Haiti*
    - *Jamaica*
    - *Mexico*
    - *Nicaragua*
    - *Panama*
    - *Paraguay*
    - *Peru*
    - *Venezuela*

15:00 – 15:30 Coffee Break

15:30 – 16:00 NDC-in-a-Box Extension: Radionuclide software given by the PTS for the States Parties and future inclusion of Seiscomp3

- *Mr. Jeffrey GIVEN (IDC)*

16:00 – 17:30 Discussion on the following topics:

- *Capacity building for establishing an NDC;*
  - Technical assistance, training and software needs
  - Usage of IMS Data and IDC products:
  - Updating Information on Current NDC Status:
  - Fostering cooperation between NDCs;
  - Cooperation and collaboration between States and CTBTO.
- Review of Country Profiles – update authorised users using NDC Registration form

- *Integrating IMS Data with National/Regional data: RSTT project and data sharing activities.*
- *Civil and scientific applications of IMS data and IDC products with emphasis on special interest to NDCs in Latin America and the Caribbean.*

17:00 – 17:30 Results of the Discussion

Tuesday, 15 October 2013

09:00 – 09:30 Potential uses of IMS Data and IDC Products for Civil and Scientific Applications: *Examples from Seismic, Hydroacoustic Infrasound and Radionuclide technologies*

- *Ms. Misrak FISSEHA (IDC)*

09:30 – 10:30 Selected presentation on National Experiences on the Use of IMS data and IDC products for Civil and Scientific Applications

- *Seismic*
  - *"Improving location of regional events in South America with IMS stations and 3D models" – Mr. M. Assumpcao, University of Sao Paulo, Sao Paulo, Brazil*
- *Seismic, Hydroacoustic and Infrasound*
  - *Uses of IMS data for Tsunami Warning System – Mr. Ronnie QUINTERO, Universidad Nacional De Costa Rica, Costa Rica NDC*
- *Infrasound*
  - *Infrasound Signals from Itaipu dam and Iguazu falls – Mr. Juan Carlos* Velazquez and *Mr. Moises Alejandro Gadea Villalba Universidad Nacional de Asuncion, Paraguay NDC*

10:30 – 11:00 Coffee Break

11:00 – 12:30 Round Table Discussion on Lesson Learned: emphasis on the possible relevant civil and scientific applications of IMS data and IDC products in Latin America and the Caribbean region.

- *Mr. Jeffrey GIVEN, Mr. Federico GUENDEL and Ms. Misrak FISSEHA (Moderators)*

12:30 – 13:30 Lunch break

13:30 – 15:00 Round Table Discussion on Lesson Learned: Future Needs Assessment, Feed back to the PTS from National Experiences on what the PTS can do for improved Capacity Building in terms of:

- Training
- Software
- Capacity Building System support
- Expert in the field

- *Mr. Jeffrey GIVEN, Mr. Federico GUENDEL and Ms. Misrak FISSEHA (Moderators)*

15:00 – 15:30 Coffee Break

15:30 – 17:30 Round Table Discussion on Lesson Learned: Future Needs Assessment, Feed back to the PTS from National Experiences on what the PTS can do for improved Capacity Building in terms of:

- Training
- Software
- Capacity Building System support
- Expert in the field

- *Mr. Jeffrey GIVEN, Mr. Federico GUENDEL and Ms. Misrak FISSEHA (Moderators)*

Wednesday, 16 October 2013

09:00 – 09:30 Overview of RSTT project: involvement of LAC region

- *Mr. Jeffrey GIVEN and Mr. Federico GUENDEL*

09:30 – 10:00 Demonstration of the CTBT Link to the International Seismological Centre ISC Database

- *Mr. Dmitry A. Storchak*

10:00 – 10:30 Wrap-Up Discussions: Suggestions & Recommendations for Increased Use of IMS Data and IDC Products including possible use for Civil and Scientific applications. Discussion points to formulate Recommendations/Suggestions for future Capacity Building efforts:

- Identifying needs on Technical assistance from PTS for establishing/strengthening NDC
- Increasing Use of IMS Data and IDC products in LAC
- Fostering cooperation between NDCs
- Establishing the Legal and Institutional Framework Nationally
- Cooperation and collaboration between States and CTBTO

- *Mr. Jeffrey GIVEN, Mr. Federico GUENDEL and Ms. Misrak FISSEHA (Moderators)*

10:30 – 11:00	Coffee Break
11:00 – 12:30	Final Collection of Comments / Suggestions & Recommendations Arising from the Workshop • *Mr. Jeffrey GIVEN, Mr. Federico GUENDEL and Ms. Misrak FISSEHA (Moderators)*
12:30 – 13:30	Lunch break
13:30 – 14:30	Installation of NDC-in-a-Box using Virtual Machine – *hands-on* • *Ms. Misrak FISSEHA(IDC) and Mr. Jeffrey GIVEN(IDC)*
14:30 – 15:00	Demonstration of NDC-in-a-Box software – *online* • *Ms. Misrak FISSEHA(IDC)*
15:00 – 15:30	Coffee Break
15:00 – 15:30	Introduction and Goals of training (Guendel)
15:30 – 16:15	RSTT Method (Myers)
16:15 – 17:00	RSTT Tomography (Begnaud)
17:00 – 17:30	Data sets for tomography and Testing (Bondar, Storchak)

Thursday, 17 October 2013

09:00 – 9:30	Arrival-Time Measurements Using GeoTool (Given)
9:30 – 10:00	Measurement of Arrival-Times on the Argentine Network (Sanchez)
9:30 – 10:00	Measurement of Arrival-Times on the Brazilian Network (Assumpsao)
10:30 – 11:00	Coffee Break
11:00- 12:00	Exercise to Measure Arrivals for GT Events on other Networks (Given)
12:00–12:30	Assessment of Travel Time Residuals (Bondar)
12:30 – 13:30	*Lunch break*
13:30 – 14:00	Previous Studies of Earth Structure in South America (Julia)
14:00– 14:30	Adjustment of the RSTT Model Based Pervious Studies (Myers)
14:30–15:00	Travel Time Residuals for the Adjusted Model (Bondar)
15:00 – 15:30	Coffee Break
15:30 – 17:00	Relocation of Events Using Regional Networks (Bondar, Myers) ak135, regional models (if provided), RSTT, RSTT-Adjusted
17:00 – 17:30	Assessment of Data Coverage for Tomography (Begnaud)

Friday, 18 October 2013

09:00 – 10:00	Use of New Data Set for Tomography (Begnaud)
10:00 – 10:30	Discussion Comparing Models and Travel Time Predictions (Begnaud, Myers, Bondar)
10:30 – 11:00	Coffee Break
11:00- 11:30	Discussion on Remaining Regions with Poor Data Coverage (Bondar)
11:30- 12:30	GT data repository at the ISC (Bondar, Storchak)
12:30 – 13:30	*Lunch break*
13:30 - 14:00	Next Steps (Guendel, Myers) Comments from participants *Publication?*
14:00 - 16:00	Wrap –up

Appendix III: Selected Photos

Group Photo

Opening remarks by Mario Bufaliza (INPRES). Jeff Given (CTBTO) and INPRES director Guiliano at the head table.

U.S./CTBTO funded students presenting their work

Hands on exercises